



Environmental, Health, and Safety Guidelines for Poultry Production

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)¹. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the **General EHS Guidelines** document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at: www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account.

¹ Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment

Applicability

The EHS Guidelines for Poultry Production include information relevant to intensive poultry (including ducks and turkeys) production. For guidance on animal welfare, see the IFC Good Practice Note "Animal Welfare in Livestock Operations."² Annex A contains a detailed description of industry activities for this sector. This document is organized according to the following sections:

Section 1.0 — Industry-Specific Impacts and Management
Section 2.0 — Performance Indicators and Monitoring
Section 3.0 — References and Additional Sources
Annex A — General Description of Industry Activities

² http://www.ifc.org/ifcext/enviro.nsf/Content/Publications_GoodPractice. Additional sources for animal welfare guidance include the Farm Animal Welfare Council available at www.fawc.org.uk and the European Commission. 2003. Integrated Pollution Prevention and Control. Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs. <http://eippcb.jrc.es/pages/FActivities.htm>

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with poultry production, which occur during the operational phase, along with recommendations for their management. Recommendations for the management of EHS issues common to most large projects during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

1.1 Environment

Environmental issues in poultry production projects primarily include the following:

- Waste management
- Wastewater
- Air emissions
- Hazardous materials
- Animal diseases

Waste Management

Solid waste generated during poultry production includes waste feed, animal waste, carcasses, and sediments and sludge from on-site wastewater treatment facilities (which may contain residual amounts of growth enhancers and antibiotics, among other hazardous constituents). Other wastes include various kinds of packaging (e.g. for feed and pesticides), used ventilation filters, unused / spoilt medications, and used cleaning materials. In addition to the following sector specific guidance, wastes should be managed and disposed of according to the guidance for hazardous and non-hazardous waste provided in the **General EHS Guidelines**.

Waste Feed

Poultry feed primarily consists of corn and soy, although other grains, pulses, root crops, and substances of animal origin (e.g. fish meal, meat and bone meal, and milk products) may also be added. The feed is typically supplemented with amino acids, enzymes, vitamins, mineral supplements, and may contain hormones antibiotics, and heavy metals (such as the commonly used arsenic compound roxarsone (3-nitro-4-hydroxyphenylarsonic acid)). Birds are generally maintained in an enclosed house, although some are moved to open ranges. Housed birds are generally fed from manual or mechanical feeders, either continuously or at set intervals. Feed can become unusable waste material if spilled during storage, loading, and unloading or during animal feeding. Waste feed, including additives, may contribute to contamination of storm water runoff, primarily due to its organic matter content.

Recommended measures to maximize the efficiency of the operation and minimize wasted feed include the following:

- Protect feed from exposure to rain and wind during processing, storage, transport and feeding.
- Maintain feed storage, transport and feeding systems in good working condition;
- Maintain records of livestock feed use;
- Consider mixing of waste feed with other recyclable materials destined for use as fertilizer; and
- For waste feed which can not be recycled due to potential biosecurity issues, alternative disposal methods should be secured in consultation with local health authorities.

Animal Waste

Poultry production operations generate significant quantities of animal waste, mainly manure, but also including other materials such as bedding. Management of animal waste depends primarily on the type of operation, which may primarily consist of dry or wet cage system or litter. Animal waste management

includes collection, transport, storage, treatment, utilization and disposal of the waste. Manure is sometimes composted, but can also be stored in stacking sheds, roofed storage areas, outside and either covered or uncovered, or occasionally in ponds until it is ready for transport to a disposal site or land application area. Manure is generally used as a fertilizer on agricultural land.

Manure contains nitrogen, phosphorus, and other excreted substances such as hormones, antibiotics, and heavy metals which are part of the feed. These substances may result in air emissions of ammonia and other gases and may pose a potential risk of contamination to surface or groundwater resources through leaching and runoff. Manure also contains bacteria and pathogens which may also potentially affect soil, water, and food resources, particularly if it is not properly managed during application as an agricultural fertilizer.³

Manure may be used as a fertilizer on agricultural land after careful assessment of potential impacts due to the presence of hazardous chemical and biological constituents. The results of the assessment may indicate the need for some level of treatment and preparation prior to its application as a fertilizer as well as the application rates.⁴

The following management measures are recommended to minimize the amount of manure produced, to facilitate handling of animal wastes, and to minimize migration of contaminants to surface water, groundwater, and air⁵:

- Implement a Comprehensive Nutrition Management Plan, including a nutrient mass balance for the entire farm. The plan should ensure that manure application does not

³ Avian influenza HPAI virus may be spread through all excretions, particularly manure, and since the virus is hardy, able to last for months under favorable cool moist conditions, and indefinitely in freezing conditions, its destruction requires enclosed treatment of the manure at relatively high temperature (above 60 degrees C).

⁴ Additional information on the application of crop nutrients is provided in the Annual Crops and Plantation Crops EHS Guidelines.

⁵ Further information on manure management is available in EC (2003)

exceed the nutrient uptake by vegetation and should include record-keeping of nutrient management practices⁶;

- Match feed content to the specific nutritional requirements of the birds in their different production / growth stages;
- Use low-protein diets, supplemented with amino acids-;
- Use low-phosphorus diets with highly digestible inorganic phosphates (e.g. for poultry, a total phosphorus reduction of 0.05 to 0.1 percent [0.5 to 1 g/kg of feed] can be achieved);⁷
- Use quality, uncontaminated feed materials (e.g. where concentrations of pesticides and dioxins are known and do not exceed acceptable levels) that contain no more copper, zinc, and other additives than is necessary for animal health;⁸
- Ensure production and manure storage facilities are constructed to prevent manure contamination of surface water and ground water (e.g. use of concrete floors, use of roof gutters on buildings to collect and divert clean storm water, and covering manure storage areas with a fixed roof or plastic sheeting);⁹
- Keep waste as dry as possible by scraping wastes instead of or in addition to flushing with water to remove waste, minimize amount of water used during cleaning (for example, by using high-pressure, low-flow nozzles);
- Use hot water or steam in cleaning activities instead of cold water, as this can reduce the amount of water used by 50 percent;

⁶ A source for good practice includes Roy et al. (2006) Plant Nutrition for Food Security, A Guide for Integrated Nutrient Management, FAO, available at <ftp://ftp.fao.org/agl/agll/docs/fpnb16.pdf>

⁷ EC (2003)

⁸ Further information regarding animal feed is available from the FAO Animal Production and Health Division, available at <http://www.fao.org/ag/againfo/home/en/home.html>

⁹ Further information regarding manure storage is available from the Livestock and Poultry Environmental Stewardship Curriculum, at http://www.lpes.org/Lessons/Lesson21/21_2_sizing_storage.pdf

- Further reduce the moisture content of dry poultry excreta (e.g. by blowing dry air over it or by conveying ventilation air through the manure pits),
- Minimize the surface area of manure in storage;
- Locate manure piles away from water bodies, floodplains, wellheads or other sensitive habitats;
- Check for leakage regularly (e.g. inspect tanks for corrosion of seams, especially those near ground level, and empty tanks at least annually or as necessary));
- Use double valves on outlets from liquid tanks to minimize the risk of unintentional release;
- Place dry manure or litter in a covered or roofed area;
- Conduct manure spread only as part of a comprehensive nutrient and waste management plan that takes into account the potentially harmful constituents of this waste including potential phyto-toxicity levels, potential concentration of hazardous substances in soils and vegetation, as well as nutrient limits and groundwater pollutant limits.¹⁰ If possible, land spread manure directly after batch cleaning (most ammonia is emitted during the manure's first month of storage) and only during periods that are appropriate for its use as plant nutrient (generally just before start of the growing season). ;
- Manure storage facilities should have sufficient capacity for 9–12 months of manure production to so that manure can be applied to agricultural land at appropriate times;
- Design, construct, operate, and maintain waste management and storage facilities to contain all manure, litter, and process wastewater including runoff and direct precipitation¹¹;
- Remove liquids and sludge from lagoons as necessary to prevent overtopping;

¹⁰ Additional information on the application of crop nutrients, see is provided in the IFC Annual Crops EHS Guideline and Plantation Crops EHS Guidelines, and in Roy et al (2006).

¹¹ Typically designed for 100-year flood event.

- Build a reserve slurry storage lagoon;
- Transport liquid effluent in sealed tankers;
- Manage sludge and sediments from wastewater treatment systems as part of the solid waste stream and according to the principles applied manure and other solid wastes with special consideration of potentially harmful constituents.

Poultry Carcasses

Poultry carcasses should be properly and quickly managed as they are a significant source of disease and odors, and can attract vectors.

Recommended measures for the management and disposal of poultry carcasses include the following¹²:

- Reduce mortalities through proper animal care and disease prevention;¹³
- Collect carcasses on a regular basis to prevent putrefaction;
- Compost only disease-free carcasses and ensure that the composting process is managed to prevent leachate and odors (e.g. sufficient cover material, proper temperature and moisture content);
- Use reliable commercially available options approved by local authorities that dispose of carcasses by rendering or

¹² Detailed guidance on poultry carcass disposal is available in Carcass Disposal: A Comprehensive Review, Kansas State University (2004) available at <http://fs.k-state.edu/research/books/carcassdisp.html>; Guidelines for Killing of Animals for Disease Control Purposes, World Organization for Animal Health (2006) Available at:

http://www.oie.int/eng/normes/mcode/en_chapitre_3.7.6.htm; Guidance Note on the Disposal of Animal By-Products and Catering Waste, UK Ministry of Agriculture, Fisheries, and Food (2001) available at <http://www.defra.gov.uk/animalh/by-prods/publicat/dispguide.pdf>; Various documents provided by the Animal Health Australia, available at <http://www.animalhealthaustralia.com.au/aahc/index.cfm?E9711767-B85D-D391-45FC-CDBC07BD1CD4#ops>

¹³ Information on animal health and disease prevention is available from Animal Health Australia, at <http://www.animalhealthaustralia.com.au/aahc/index.cfm?E9711767-B85D-D391-45FC-CDBC07BD1CD4#ops> and from the United States Department of Agriculture (USDA) Animal and Plant Inspection Service, available at http://www.aphis.usda.gov/animal_health/index.shtml and in EC (2003).

incineration, depending on the cause of fatality.

Incineration should only be conducted in permitted facilities operating under international recognized standards for pollution prevention and control;¹⁴

- Where no authorized collection of carcasses is available, on-site burial may be one of the only viable alternatives, if allowed by the authorities. Whether on-site or off-site, the burial area should be accessible to earthmoving machinery and be designed and located so as to avoid contamination by vapors or leachate from buried, decaying carcasses; Open burning should be avoided.¹⁵

Wastewater

Industrial Process Wastewater

Poultry operations may generate effluents from various sources including runoff from poultry housing, feeding, and watering; from waste storage and management facilities. Waste management activities such as land application of manure, may generate non-point source effluents due to runoff. Both types of effluents have the potential to contaminate surface water and groundwater with nutrients, ammonia, sediment, pesticides, pathogens, and feed additives, such as heavy metals, hormones, and antibiotics.¹⁶ Effluents from poultry operations typically have a high content of organic material and consequently a high biochemical oxygen demand (BOD) and chemical oxygen demand (COD), as well as nutrients and suspended solids (TSS).

Effective waste management, as described above, is critical to minimizing discharges to surface water and ground water. In

¹⁴ Examples of key environmental issues associated with incineration facilities are available in the EHS Guidelines for Waste Management Facilities.

¹⁵ Many countries forbid burial of carcasses. More information on the treatment of dead animals can be found in the Waste and By-products section of the EHS Guidelines for Poultry Processing.

¹⁶ Forty percent of antibiotics manufactured are fed to livestock as growth enhancers. Kelly Reynolds, Pharmaceuticals in Drinking Water Supplies, *Water Conditioning and Purification Magazine*, June 2003: Volume 45, Number 6. <http://www.wcponline.com/column.cfm?T=T&ID=2199>.

addition, the following management techniques are recommended to further reduce the impacts of water runoff from poultry operations.

- Reduce water use and spills from animal watering by preventing overflow of watering devices and using calibrated, well-maintained self-watering devices;
- Install vegetative filters to trap sediment;
- Install surface water diversions to direct clean runoff around areas containing waste;
- Implement buffer zones to surface water bodies, as appropriate to local conditions and requirements, and avoiding land spreading of manure within these areas.¹⁷

Process Wastewater Treatment

Techniques for treating industrial process wastewater in this sector include sedimentation for suspended solids reduction using clarifiers or settling ponds; flow and load equalization; biological treatment for reduction of soluble organic matter (BOD); biological nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering of residuals and composting or land application of wastewater treatment residuals of acceptable quality. Additional engineering controls may be required (i) if pass through of active ingredients (residual amounts of growth enhancers and antibiotics, among other hazardous constituents) is an issue, and (ii) to contain and neutralize nuisance odors.

Management of industrial wastewater and examples of treatment approaches are discussed in the **General EHS Guidelines**. Through use of these technologies and good practice techniques for wastewater management, facilities should meet the Guideline Values for wastewater discharge as

¹⁷ U.S. EPA, National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs), 68 FR 7175-7274. <http://www.epa.gov/fedrgstr/EPA-WATER/2003/February/Day-12/w3074.htm>

indicated in the relevant table of Section 2 of this industry sector document.

Other Wastewater Streams & Water Consumption

Guidance on the management of non-contaminated wastewater from utility operations, non-contaminated stormwater, and sanitary sewage is provided in the **General EHS Guidelines**.

Contaminated streams should be routed to the treatment system for industrial process wastewater. Recommendations to reduce water consumption, especially where it may be a limited natural resource, are provided in the **General EHS Guidelines**.

Air Emissions

Air emissions from poultry production include primarily ammonia (e.g. management of animal waste), odors (e.g. animal housing and waste management), and dust (e.g. feed storage, loading and unloading, and waste management activities). Effective waste management, as described above, is critical to minimizing emissions of air pollutants. In addition, the management techniques discussed below are recommended to further reduce the impacts of air emissions from poultry operations.

Ammonia and Odors

Ammonia gas and other sources of odor are generated primarily during denitrification of manure and can be released directly into the atmosphere at any stage of the manure handling process, including through ventilation of buildings and manure storage areas. Ammonia gas levels also may be affected by the ambient temperature, ventilation rate, humidity, stocking rate, litter quality, and feed composition (crude protein). Ammonia gas (NH₃) has a sharp and pungent odor and can act as an irritant when present in elevated concentrations. Ammonia gas deposition into surface waters may contribute to their eutrophication. Release of ammonia gas also reduces the nitrogen content and, therefore, the fertilizer value of the manure.

Recommended measures to reduce impacts of ammonia and odors¹⁸ include the following:

- Consider the siting of new facilities taking into account distances to neighbors and the propagation of odors;
- Control the temperature, humidity, and other environmental factors of manure storage to reduce emissions;
- Consider composting of manure to reduce odor emissions;
- Reduce emissions and odors during land application activities by applying a few centimeters below the soil surface and by selecting favorable weather conditions (e.g. wind blowing away from inhabited areas);
- If necessary, apply chemicals (e.g. urinase inhibitors) weekly to reduce conversion of nitrogen to ammonia;¹⁹

Dust

Dust can reduce visibility, cause respiratory problems, and facilitate transport of odors and diseases. Measures recommended to minimize dust generation include the following.

- Install dust collection systems (including use of misters) in areas with dusty operations (e.g. feed grinding);
- Implement fugitive dust-control measures (e.g. wetting vehicle parking lots and frequently traveled dirt roads, as necessary);
- Ensure the prevention of bioaerosols emissions, which may contain disease-causing agents, through the application of the above-reference dust and emissions control measures in manure production and storage facilities.

Hazardous Materials

Hazardous materials are used throughout the poultry production cycle (e.g. disinfecting agents, antibiotic and hormonal

¹⁸ Additional detail is available in EC (2003).

¹⁹ *Use of Urease Inhibitors to Control Nitrogen Loss From Livestock Waste*, U.S. Department of Agriculture, 1997.

products). Guidance on the handling, storage, and transport of hazardous materials is provided in the **General EHS**

Guidelines.

Use of Pesticides

Pesticides may be applied directly to birds or to structures (e.g. barns and housing units) and to control pests (e.g. parasites and vectors) using dipping vats, sprayers, and foggers. Pesticides can also be used to control predators. The potential pollutants from pesticides include the active and inert ingredients, diluents, and persistent degradation products. Pesticides and their degradation products may enter groundwater and surface water in solution, in emulsion, or bound to soil particles. Pesticides may, in some instances, impair the uses of surface waters and groundwater. Some pesticides are suspected or known to cause chronic or acute health hazards for humans as well as adverse ecological impacts.

By reducing pesticide use, poultry production operators may reduce not only the environmental impacts of their operations, but also production costs. Pesticides should be managed to avoid their migration into off-site land or water environments by establishing their use as part of an Integrated Pest Management (IPM) strategy and as documented in a Pesticide Management Plan (PMP). The following stages should be considered when designing and implementing an IPM strategy, giving preference to alternative pest management strategies, with the use of synthetic chemical pesticides as a last option.

Integrated Pest Management

IPM uses an understanding of the life cycle of pests and their interaction with the environment in combination with available pest control methods to keep pests at a level that is within the economically damaging threshold with a minimum of adverse environmental and human health impacts. Recommended IPM

approaches in the mammalian livestock industry include the following:

- Maintain structures to keep out pests (e.g. plug holes, seal gaps around doors and windows);
- Use mechanical controls (e.g. traps, barriers, light, and sound) to kill, relocate, or repel pests;
- Use predators to control pests. Protect natural enemies of pests by providing a favorable habitat (e.g. bushes for nesting sites and other indigenous vegetation) that can house pest predators;
- Use good housekeeping practices in barns and other facilities to limit food sources and habitat for pests;
- Improve drainage and reduce standing water to control mosquito populations;
- Consider covering manure piles with geotextiles (which allow water to enter the pile and maintain composting activity) to reduce fly populations;
- If pesticides are used, identify in the IPM plan the need for the pesticide and evaluate their effectiveness, as well as potential environmental impacts, to ensure that the pesticide with the least adverse impact is selected (e.g. nonleachable pesticides).

Good Management Practices

If the application of pesticides is warranted, spill prevention and control measures consistent with the recommendations applicable to pesticides and other potential hazardous materials as noted in the **General EHS Guideline** should be followed.

In addition, the following actions specific to poultry production should be taken to reduce environmental impacts:

- Train personnel to apply pesticides according to planned procedures, while using the necessary protective clothing.

Where feasible or required, pesticide application personnel should be certified for this purpose;²⁰

- Review the manufacturer's instructions on the maximum recommended dosage and treatment, as well as published experiences on the reduced rate of pesticide applications without loss of effect, and apply the minimum effective dose;
- Avoid the use of pesticides that fall under the World Health Organization Recommended Classification of Pesticides by Hazard Classes 1a and 1b.
- Avoid the use of pesticides that fall under the World Health Organization Recommended Classification of Pesticides by Hazard Class II if the project host country lacks restrictions on distribution and use of these chemicals, or if they are likely to be accessible to personnel without proper training, equipment, and facilities to handle, store, apply, and dispose of these products properly;
- Avoid the use of pesticides listed in annexes A and B of the Stockholm Convention, except under the conditions noted in the convention;²¹
- Use only pesticides that are manufactured under license and registered and approved by the appropriate authority and in accordance with Food and Agriculture Organization's (FAO's) International Code of Conduct on the Distribution and Use of Pesticides;
- Use only pesticides that are labeled in accordance with international standards and norms, such as the FAO's Revised Guidelines for Good Labeling Practice for Pesticides;

- Select application technologies and practices designed to reduce unintentional drift or runoff, only as indicated in an IPM program, and under controlled conditions;
- Maintain and calibrate pesticide application equipment in accordance with the manufacturer's recommendations;
- Store pesticides in their original packaging, and in a dedicated location that can be locked and properly identified with signs, with access limited to authorized persons. No human or animal food should be stored in this location;
- Mixing and transfer of pesticides should be undertaken by trained personnel in ventilated and well lit areas, using containers designed and dedicated for this purpose.
- Used pesticide containers should not be used for any other purpose (e.g. drinking water) and should be managed as a hazardous waste as described in the **General EHS Guidelines**. Disposal of containers contaminated with pesticides also should be done in a manner consistent with FAO guidelines and with manufacturer's directions;²²
- Purchase and store no more pesticide than needed and rotate stock using a "first-in, first-out" principle so that pesticides do not become obsolete. Additionally, the use of obsolete pesticides should be avoided under all circumstances;²³ A management plan that includes measures for the containment, storage and ultimate destruction of all obsolete stocks should be prepared in accordance to guidelines by FAO and consistent with country commitments under the Stockholm, Rotterdam and Basel Conventions.
- Implement groundwater supply wellhead setbacks for pesticide application and storage
- Maintain records of pesticide use and effectiveness.

²⁰ For example, the US EPA classifies pesticides as either "unclassified" or "restricted." All workers that apply unclassified pesticides must be trained according to the Worker Protection Standard (40 CFR Part 170) for Agricultural Pesticides. Restricted pesticides must be applied by or in the presence of a certified pesticide applicator. For more information, see <http://www.epa.gov/pesticides/health/worker.htm>.

²¹ The Stockholm Convention on Persistent Organic Pollutants (2001), controls the use of the following POPs-pesticides: Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex, and Toxaphene.

²² See FAO Guidelines for the Disposal of Waste Pesticides and Pesticide Containers on the farm.

²³ See the FAO publication on pesticide storage and stock control manual. FAO Pesticide Disposal Series No. 3 (1996).

Animal Diseases

Animal disease-causing agents can spread rapidly, especially in intensive livestock operations. Animal diseases can enter a facility with new animals, on equipment, and on people. Some diseases can weaken or kill large numbers of animals at an infected facility. Both poultry manure and carcasses contain pathogenic organisms which can infect humans, for example viruses such as Avian Influenza (strain HN51), and parasites such as parasitical worms.

In some cases, the only remedy available to an operation is to sacrifice an entire group of animals to prevent the spread of the disease to other parts of the facility or to other facilities. The procedures to protect against the spread of animal diseases will depend on the type of animal at a facility, the way the diseases of concern spread to and infect animals, and the vulnerability of the animals to each specific disease.

The key to developing adequate disease-prevention procedures is to find accurate information about animal diseases and how to prevent them. Some of the recommended general types of management methods to reduce the potential for the spread of animal pathogens include the following:

Recommended management measures to minimize the potential for the spread of poultry pathogens include:

- Establish sound biosecurity protocols for the entire poultry operation that control animals, feed, equipment, and personnel, entering the facility (for example, quarantine periods for new animals, washing and disinfecting equipment, showering and protective clothing and footwear for personnel, and keeping out stray animals, rodents and birds);
- Control farm animals, equipment, personnel, and wild or domestic animals entering the facility (e.g. quarantine periods for new animals, washing and disinfecting crates, disinfection and coverage of shoes before entry into bird

housing zones, providing protective clothing to personnel, and closing holes in buildings to keep out wild animals);

- Prevent the interaction of wild birds with feed, as this interaction could be a factor in the spread of avian influenza from sparrows, crows, etc.
- Vehicles that go from farm to farm (e.g. transport of veterinarians, farm suppliers, buyers, etc.) should be subject to special precautions such as limiting their operation to special areas with biosecurity measures, spraying of tires and treating parking areas with disinfectants;
- Sanitize bird housing areas;
- Establish a detailed animal health program supported by the necessary veterinary and laboratory capability. Identify and segregate sick birds²⁴ and develop management procedures for adequate removal and disposal of dead birds).²⁵
- Where possible establish all in- all out systems with only one age group per farm;
- Workers on multiple age bird farms should always work with the youngest birds first before moving on to the older birds;
- Train workers in the application of animal health products.

²⁴ Information on animal health and disease prevention is available from Animal Health Australia, at <http://www.animalhealthaustralia.com.au/aahc/index.cfm?E9711767-B85D-D391-45FC-CDBC07BD1CD4#ops> and from the United States Department of Agriculture (USDA) Animal and Plant Inspection Service, available at http://www.aphis.usda.gov/animal_health/index.shtml

²⁵ For further information on culling and disposal of carcasses, in addition to animal health issues, see Carcass Disposal: A Comprehensive Review, Kansas State University (2004) available at <http://fss.k-state.edu/research/books/carcassdisp.html>; Guidance Note on the Disposal of Animal By-Products and Catering Waste, UK Ministry of Agriculture, Fisheries, and Food (2001) available at <http://www.defra.gov.uk/animalh/by-prods/publicat/dispguide.pdf>; and various documents provided by the Animal Health Australia, available at <http://www.animalhealthaustralia.com.au/aahc/index.cfm?E9711767-B85D-D391-45FC-CDBC07BD1CD4#ops>

1.2 Occupational Health and Safety

Occupational Health and Safety hazards related to the daily operations of the poultry sector can be grouped into five categories:

- Physical hazards
- Confined spaces
- Exposure to chemical hazards
- Exposure to organic dust
- Exposure to biological agents

Exposure to Physical Hazards

Workers in poultry production facilities may become exposed to a series of physical hazards related to equipment and vehicle operation and repair, trip and fall hazards, and lifting heavy weights, which are common to other industries. Physical hazards should be prevented and controlled according to applicable guidance presented in the **General EHS Guideline**.

Additional recommendations applicable to poultry production include:

- Prevention of falls into openings for water supply systems, underground manure storage tanks, and other confined spaces through installation of covers, fences, and other fall prevention methods;
- Training on correct bird handling techniques and provision of appropriate personal protective equipment (PPE), such as gloves and aprons, to prevent scratches.

Confined Spaces

Occupational health and safety hazards associated with confined spaces on farms (e.g. manure pits, silos, grain bins, water tanks, or inadequately ventilated buildings) include the risk of asphyxiation, primarily due to the accumulation of methane. Entry to all confined spaces should be restricted and

should be subject to permitted supervision by properly trained persons as described in the **General EHS Guidelines**.

Chemical Hazards

Potentially hazardous substances used in poultry production activities may include pesticides, disinfecting agents, minerals, antibiotic and hormonal products. Potential exposures to pesticides should be managed according to the recommendations provided above (Hazardous Materials Management section). Additionally, all potential chemical exposures should be prevented and controlled according to applicable guidance presented in the **General EHS Guideline**.

Exposure to pesticides

Potential exposures to pesticides include dermal contact and inhalation during their preparation and application as well as ingestion due to consumption of contaminated water. The effect of such impacts may be increased by climatic conditions, such as wind, which may increase the chance of unintended drift, or high temperatures, which may be a deterrent to the use of personal protective equipment (PPE) by the operator.

Recommended management practices include the following:

- Train personnel to apply pesticides and ensure that personnel have received the necessary certifications,²⁶ or equivalent training where such certifications are not required;
- Respect post-treatment intervals to avoid operator exposure during reentry to crops with residues of pesticides;

²⁶ The US EPA classifies pesticides as either "unclassified" or "restricted." All workers that apply unclassified pesticides must be trained according to the Worker Protection Standard (40 CFR Part 170) for Agricultural Pesticides. Restricted pesticides must be applied by or in the presence of a certified pesticide applicator. For more information, see <http://www.epa.gov/pesticides/health/worker.htm>

- Respect preharvest intervals to avoid operator exposure to pesticide residues on products during harvesting;
- Ensure hygiene practices are followed (in accordance to FAO and PMP) to avoid exposure of family members to pesticides residues.

Air Quality

Source of dust in poultry production operations include handling and storage of feed ingredients which may include particles from grain, mites, fungi, and bacteria, as well as inorganic material such as limestone. Other sources of dust include bird manure and associated bioaerosols.

Job functions with a potentially higher incidence of exposure to dust include cleaning of silos and grain hoppers, milling of feed grain, and handling of poultry waste. Some dusts may contain antigens that can cause severe irritation to the respiratory tract. Acute toxic alveolitis, otherwise known as organic dust toxic syndrome, can accompany brief, occasional exposures to heavy concentrations of organic dust and moldy feed materials in agricultural environment.

In addition to the general dust exposure prevention and control guidance provided in the occupational health and safety section of the **General EHS Guidelines**, recommendations for dust control specific to poultry production include:

- Use local air extraction devices at dust generating equipment, such as silos and grinders;
- Ensure that workers potentially exposed to dust and bioaerosols, such as catching gangs, are provided with adequate respiratory protection including properly fitted masks equipped with filters especially designed to capture dust and micro-organisms;
- Store only dry feed and grain to minimize microorganism growth.

Exposure to Biological Agents

Workers may be exposed to a range of pathogens such as bacteria, fungi, mites and viruses (including “bird flu”) transmitted from live birds, excreta, carcasses and parasites and ticks²⁷. Workers may also be exposed to skin sensitizers, such as dander from bird feathers. If antibiotics are used in feed, antibiotic resistant micro-organisms might develop in the gastrointestinal tract of birds. Resistant bacteria can potentially infect humans on or in the vicinity of the farm.

Management measures that should be taken to avoid the negative consequences of worker exposure to biological agents²⁸ include the following.

- Inform workers of potential risks of exposure to biological agents and provide training in recognizing and mitigating those risks;
- Provide personal protective equipment to minimize all forms of exposure to materials potentially containing pathogens;
- Ensure that those that have developed allergic reactions to biological agents are not working with these substances.

Additional guidance applicable to the management of biological hazards is provided in the **General EHS Guidelines**.

1.3 Community Health and Safety

Community health and safety issues associated with the construction and decommissioning of poultry production facilities are similar to those of other large projects and are addressed in

²⁷ European Agency for Safety and Health at Work (OSHA). European Network. FAQ on Agriculture Sector. http://agency.osha.eu.int/good_practice/sector/agriculture/faq_agriculture

²⁸ Detailed guidance on occupational health and safety measures to protect against Avian Flu can be found in Occupational Health and Safety Administration (OSHA), Protecting Employees from Avian Influenza Viruses (2006), available at: http://www.osha.gov/OshDoc/data_AvianFlu/avian_flu_guidance_english.pdf

the **General EHS Guidelines**. Community health and safety hazards specific to poultry operations include the potential spread of animal diseases already addressed in this document as well as the following food safety issues.

Food Safety Impacts and Management

The main veterinary drugs used in poultry are antibiotics. These are used to prevent and treat bacterial diseases. The development of antibiotic resistance by pathogenic bacteria is of concern and arises when bacteria acquire resistance to one or more of the antibiotics to which they were formerly susceptible. That resistance eventually makes the antibiotics ineffective in treating specific microbial diseases in humans.²⁹ In addition, when antibiotics are unintentionally consumed as residues in food, the amount ingested cannot be quantified or monitored and may cause direct health concerns, such as aplastic anemia, posing a serious risk to human health.

Concerning risks to community health and safety from the ingestion of hazardous substances in poultry products, the FAO/WHO *Codex Alimentarius* provides guidance on veterinary drug residues and pesticide residues. For example the Codex contains 46 maximum residue limits (MRLs) for veterinary drugs in poultry products (including eggs), as well as MRLs for pesticide residues in chickens and eggs.³⁰ The official Codex Standards also contains standards for chicken products, for example the Recommended International Code of Hygienic Practice for Egg Products. Observance of MRLs is required by law under some national jurisdictions and is encouraged elsewhere.

²⁹ FAO (2002b).

³⁰ The *Codex Alimentarius* provides Maximum Residue Limits (MRLs) for veterinary drug residues and pesticide residues in all major food raw materials, including chicken meat and eggs. The FAO/WHO veterinary drug MRL database is: http://www.codexalimentarius.net/mrls/vetdrugs/jsp/vetd_q-e.jsp The FAO/WHO pesticide MRL database is: http://www.codexalimentarius.net/mrls/pestdes/jsp/pest_q-e.jsp

The following actions should be taken at the system level to limit the use of antibiotics:

- Facilities involved in livestock production should use a veterinary service on an annual or more frequent basis to review and assess the health of the stock and employees' competence and training. With the assistance of the veterinary service, facilities should develop a veterinary health plan to include the following aspects³¹:
 - Summary of major diseases present and potentially present;
 - Disease prevention strategies;
 - Treatments to be administered for regularly encountered conditions;
 - Recommended vaccination protocols;
 - Recommended parasite controls;
 - Medication recommendations for feed or water.

If antibiotics are recommended, the following measures should be considered:

- Apply only approved antibiotics in strict accordance with the manufacturer's instructions to ensure responsible and correct use;
- Apply approved antibiotics that are purchased and utilized on prescription and under the guidance of a qualified professional even where no prescription is required;
- Prepare a contingency plan that specifies how antibiotics should be applied following the identification of disease outbreaks;
- Store antibiotics in their original packaging, in a dedicated location that:
 - Can be locked and is properly identified with signs, with access limited to authorized persons

³¹ For more information, see EUREPGAP guidance on integrated farm assurance at <http://www.eurepgap.org/farm/Languages/English/documents.html>

- Can contain spills and avoid uncontrolled release of antibiotics into the surrounding environment
- Provides for storage of containers on pallets or other platforms to facilitate the visual detection of leaks
- Avoid stockpiles of waste antibiotics by adopting a "first-in, first-out" principle so that they do not exceed their expiration date. Any expired antibiotics should be disposed of in compliance with national regulations

2.0 Performance Indicators and Monitoring

2.1 Environment

Emissions and Effluent Guidelines

Table 1 presents effluent guidelines for this sector for concentrated livestock feeding operations generating point source effluents. Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks. These guidelines are achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques discussed in the preceding sections of this document. These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

Poultry production operations may also be characterized by non-point sources of effluents or emissions which may need to be monitored through the proper implementation of nutrient management strategy as described above, taking into consideration potential impacts to human health and the

environment from the presence of disease-agents in the waste streams. The objective should be the minimization of "excess" nutrients and other pollutants in runoff with additional considerations for discharge to surface waters as described in the **General EHS Guidelines**.

Table 1. Effluent levels for poultry production

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD ₅	mg/l	50
COD	mg/l	250
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Temperature increase	°C	<3 ^b
Total coliform bacteria	MPN ^a / 100 ml	400
Active Ingredients / Antibiotics	To be determined on a case specific basis	
Notes:		
^a MPN = Most Probable Number		
^b At the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity		

Table 2 provides a typical range of ammonia emissions from poultry housing systems. These values are provided for comparative purposes only, to help establish a benchmark at the project level.

Resource Use

The following tables 2, 3, 4 and 5 provide examples of resource consumption indicators for energy, water, materials, and waste in this sector. Industry benchmark values are provided for comparative purposes only and individual projects should target continual improvement in these areas. These benchmarks are

EC based and would need to be amended for a hotter climate especially where pad cooling is used for environmental control.

Table 2. Ammonia emissions from poultry production systems^a

Housing Type	Unit ^b	Average emission factor
Laying hens in cages with deep pits underneath for gathering and storing manure	g NH3 LU-1 h-1	6.9
Laying hens in cages with belt cleaning once weekly	g NH3 LU-1 h-1	2.9
All birds kept on litter	g NH3 LU-1 h-1	5.5
NOTES		
^a Adapted from: DEFRA (2002)		
^b The weight of ammonia emitted per unit of time and per liveweight housed (liveweight means the weight of the bird).		

Table 3. Energy consumption in poultry production

Activity	Estimated energy consumption ^a	
	Broilers	Laying hens
Local heating	13 - 20	
Feeding	0.4 - 0.6	0.5 - 0.8
Ventilation	0.10 - 0.14	0.13 - 0.45
Lighting		0.15 - 0.40
Egg preservation ^b		0.30 - 0.35
NOTES		
^a Wh per bird per day.		
^b Wh per egg per day.		
Source: EC (2003)		

Table 4. Water consumption in poultry production

Type	Water consumption of poultry			Annual water consumption for cleaning of areas ^d
	Average ratio water/feed ^a	Water consumption per cycle ^b	Annual water consumption ^c	
Broiler	1.7 – 1.9	4.5 – 11	40 – 70	0.012-0.120
Laying hen	1.8 – 2.0	10	83 – 120	Layers (cages): 0.01 Layers (deep litter): >0.025

Note: Adapted from: EC (2003). Integrated Pollution Prevention and Control (IPPC). Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs. July 2003. Tables 3.11-12. p. 104-5.
a Liters/kg
b Liters/head/cycle
c Liters/bird place/year
d Use in m³ per m² per ye.ar

Table 5. Nitrogen losses from poultry manure management

Manure Management system	N excreted	Losses from			Total losses to air	Total available for crops
		Building	Storage	Field		
Pounds nitrogen / head / year						
Surface application	0.9	0.18	0.03	0.17	0.38	0.51
Incorporate	0.9	0.18	0.03	0.04	0.25	0.65
Alum, incorporate	0.9	0.03	0.04	0.21	0.28	0.62

Source: Marcel Aillery, et al., USDA Economic Research Service, Managing Manure to Improve Air and Water Quality, Economic Research Report No. (ERR9) 65 pp, September 2005. <http://www.ers.usda.gov/publications/ERR9/>

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project. Monitoring frequency should be

sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on monitoring programs is provided in the **General EHS Guidelines**.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV[®]) occupational exposure guidelines and Biological Exposure Indices (BEIs[®]) published by American Conference of Governmental Industrial Hygienists (ACGIH),³² the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),³³ Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),³⁴ Indicative Occupational Exposure Limit Values published by European Union member states,³⁵ or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this

³² Available at: <http://www.acgih.org/TLV/> and <http://www.acgih.org/store/>

³³ Available at: <http://www.cdc.gov/niosh/hpg/>

³⁴ Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992

³⁵ Available at: http://europe.osha.eu.int/good_practice/risks/ds/oe/

sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)³⁶.

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals³⁷ as part of an occupational health and safety monitoring program.

Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

³⁶ Available at: <http://www.bls.gov/iif/> and <http://www.hse.gov.uk/statistics/index.htm>

³⁷ Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

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Annex A: General Description of Poultry Industry Sector Activities

This description covers the production of laying hens, broiler chickens, turkeys, ducks and gamebirds. Poultry production generally includes the following operations: feed manufacture, storage and handling, poultry housing, feeding and watering, egg and/or live bird collection, management of animal waste, and disease and pest control. Modern poultry production primarily occurs in enclosed buildings to protect the birds from weather, predators, and the spread of diseases. Some specialty and small farm operations move birds outdoors during at least a portion of their development. Use of enclosed buildings allows producers to increase production efficiency and reduce labor inputs, but concentrating many birds in one place also results in large volumes of poultry manure being produced in small areas.

Poultry production can be a major source of odor. Odor emissions are mainly derived from production buildings and manure storage, and from manure spreading to fertilize agricultural land. Excreta from poultry contain uric acid, which is converted to volatile ammonia under certain conditions. Emissions of ammonia from poultry buildings contribute to the acidification of soils and water and can have a negative impact on populations of acid-sensitive flora. Considerations should also be given to the protection of surface and groundwater resources in the vicinity of the facility and the areas where manure spreading is practiced because nutrient run-off into water courses and leachate into the groundwater are environmental problems.

The characteristics of poultry manure are dependent on the following characteristics: water consumption, feed quality, feed intake, and the amount and characteristics of litter used, if any. These need to be taken into account when estimating the quantity and associated characteristics of the manure from a

specific unit³⁸. The required land area and application rates are determined by a calculated nutrient mass balance to ensure that the nutrient load resulting from land spreading does not become an environmental problem.

In the second type, modern intensive poultry production facilities function without an agricultural hinterland as other methods are utilized for the disposal of the manure, for example commercial sale as a fuel or as a fertilizer for agricultural application.

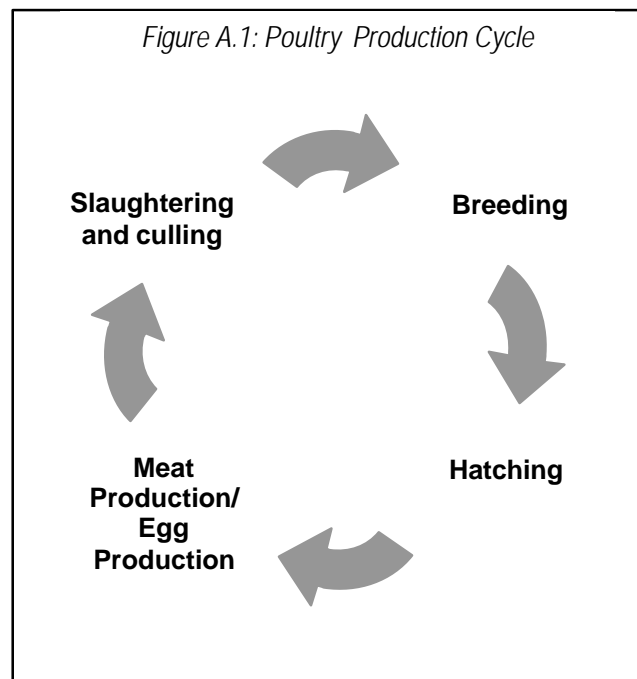


Figure A.1 presents a generic production cycle for the production of poultry. Modern production poultry production systems typically consist of a number of highly specialized units that cover a certain stage of the bird life cycle. There is also a trend for the poultry supply chain to become vertically integrated, with one company managing the entire value chain.

³⁸ Irish EPA. 1998. Integrated Pollution Control Licensing. Batneec Guidance Note For The Poultry Production Sector. P. 6.

Figure A.2 identifies the principal operations in poultry production.

Breeding

Two basic poultry types are used depending on the type of production: (i) broiler chickens and (ii) egg laying hens. Broiler chickens are raised for meat products and are characterized by a low feed conversion rate, expressed in kg feed/kg produced meat and a high weight gain. Egg laying hens are raised for egg production and are characterized by a high egg laying rate, small size and a low feed conversion rate, expressed in kg feed/kg produced egg. In certain countries, cultural traditions also play a role in the type of egg laying hens selected, for example desired color of egg shell.

Breeder farms specialize in the production of fertilized eggs for either broiler production or egg production. These commercial operations may have 20,000 birds or more. Specific ratios of male/female broilers are used to ensure the fertility of hatching eggs. Breeder broilers are generally kept in a barn with a slotted floor or with a wire floor with litter in the middle of the floor to encourage mating. Nesting boxes are provided so that birds are able to lay eggs without disturbance and to keep eggs clean and facilitate collection³⁹. The eggs are collected daily, assessed for quality, and stored in plastic trays in a controlled environment before being transferred to the hatchery.

Hatching

The eggs are hatched at special hatcheries. These are centralized and typically receive fertilized eggs from several breeder farms. The eggs may be stored for a period of up to 10 days before being placed in incubators that control temperature and humidity and stimulate embryonic development. Hatching typically takes 21 days. The hatchlings may be vaccinated and

gender sorted. The day-old broiler chicks are delivered to broiler farms. Chicks from egg laying stock are gender sorted and the females delivered for egg production. Males are killed and disposed of.

Growth and Egg Production

This is the main operational phase of the production cycle. The production infrastructure as well as issues relating to manure production and feed materials are described below.

Production Infrastructure

The need and specifications for poultry production buildings depends on which climatic region the production is located in, and the type of production. Day-old chicks from the hatchery are placed in the brooder rings upon arrival. Broilers that have reached a given size may be given access to the entire barn. Broiler chickens are kept in large, undivided houses with a deep layer of litter (such as sawdust, chopped straw, or shredded newspaper) on the floor. The grow-out phase lasts 35 – 45 days before the broilers reach market weight and are delivered to the slaughterhouse.

Immature egg laying hens (termed “pullets”) are initially kept in either open barn systems similar to broiler chicken houses or in cages. At an age of 16 – 18 weeks the pullets are transferred to egg laying facilities and are kept in laying units for about 12 months. After this period of time, egg laying rates typically fall and the birds are culled and sent to a slaughterhouse. The laying units are either cage based or allow free movement. Cage-based systems use different arrangements to stack the cages, for example the A-frame model, and consequently differing methods to gather the excreta, for example on conveyor belts or allowing it to drop into deep pits under the cages. Barn systems that allow free movement of the hens are open and have part-slatted, part-litter floor as well as a central pit for bird droppings.

³⁹ US EPA (Environmental Protection Agency). National Agricultural Compliance Centre. Agriculture Centre. Ag101. Poultry Production. <http://www.epa.gov/oecaagct/ag101/poultry.html>

All commercial poultry production is batch based – typically 42 days or 12 months depending on production. After each batch the birds are removed, the manure is removed and the buildings are cleaned and disinfected. After a period of time, a new batch is placed in the building. The building has automatic feeding, watering, temperature control and ventilation systems. Buildings may be either naturally ventilated (air change due to wind) or mechanically ventilated (where air is drawn into the buildings through vents due to a negative pressure created with wall fans that exhaust inside air)⁴⁰. The production facilities are kept as closed units with strict control on access by employees and visitors. Eggs may be washed prior to sale, generating waste water effluent containing organic matter. Associated infrastructure common to broilers and egg layers includes silos for feed concentrate, manure storage facilities and containers for dead birds.

Feed

Poultry feed can be produced in the farm system but it is normally delivered from a feed mill. Feed is a concentrate consisting of ground corn to provide energy and soybean meal to produce protein. The feeding depends on the nutrient requirements of the different types and age of the poultry and vitamins, minerals, and other supplements may also be added.

Manure

The poultry manure in litter based production systems is removed from the production building after each batch of birds. The manure produced combined with the litter has a dry matter content of around 70%- 80% and is stored outside in appropriate storage facilities. Laying hen houses typically use cage or other systems that do not require litter. The poultry manure from cage systems either falls into deep pits located underneath the cages, or onto a conveyor belt. The manure may be dried to a dry matter content of around 50% by either blowing dry air onto it (typically used in conveyor belt systems) or by letting ventilation air dry it (typically used in deep pits). The manure pits are emptied after each batch using mechanical equipment and until then provide long term storage of the manure indoors. Conveyor belt systems are emptied several times a month. Manure from cage systems is stored indoors in specially designed building to keep the manure dry.

Slaughtering and Culling

Fully grown broiler chickens are sold to the market and slaughtered for production of poultry meat. Culling is the process whereby sick birds that show signs of weakness are removed from the production, killed, and disposed of according to local legislation. Spent hens are sent to slaughter or rendering.

⁴⁰ US EPA (Environmental Protection Agency). National Agricultural Compliance Centre. Agriculture Centre. Ag101. Poultry Production.
<http://www.epa.gov/oecaagct/aq101/poultry.html>

Figure A-2. Principal Operations in Poultry Livestock Production

